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(54) **ANTENNA BEAM VIRTUALIZATION FOR WIDE BEAM WIRELESS COMMUNICATION**

ANTENNENSTRAHLVIRTUALISIERUNG FÜR DRAHTLOSE BREITSTRAHLKOMMUNIKATION

VIRTUALISATION DE FAISCEAU D'ANTENNE POUR COMMUNICATION SANS FIL À LARGE FAISCEAU

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(73) Proprietor: **Telefonaktiebolaget LM ERICSSON (PUBL)**
16483 Stockholm (SE)

(72) Inventors:
- **PETERSSON, Sven**
  433 69 Sävedalen (SE)
- **ATHLEY, Fredrik**
  429 30 Kullavik (SE)
- **NILSSON, Andreas**
  413 13 Göteborg (SE)

(74) Representative: **Ericsson Patent Development**
Torshamnsgatan 21-23
164 80 Stockholm (SE)

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Description

TECHNICAL FIELD

[0001] The present disclosure relates to wireless communication systems where wireless devices connect to a network of access points, or transmission points (TRP). The disclosure is of particular relevance to the fifth generation (5G) new radio (NR) systems defined by the third generation partnership program (3GPP) but can also be applied in other types of wireless communication systems comprising configurable antenna arrays.

BACKGROUND

[0002] Most wireless access networks comprise procedures for initial access to the network. These routines involve, e.g., synchronization procedures, authentication mechanisms, and exchange of various control parameter values.

[0003] The 3GPP 5G communication systems define a synchronization signal block (SSB) which is transmitted from the access point (gNB) to wireless devices. The SSB is discussed in, e.g., 3GPP TS 38.101 version 16.3.0, 3GPP TS 38.211 version 16.1.0, and 3GPP TS 38.213 version 16.1.0. A wireless device wishing to connect to a 5G access network receives the SSB transmission from the gNB, and then performs a random access (RA) procedure in order to synchronize with the network.

[0004] Many NR TRPs comprise advanced antenna systems (AAS) that enable beamforming techniques which allow narrow high gain antenna beams to be directed at specific wireless devices. However, the initial access procedure, i.e., the transmission of the SSB on downlink (DL) from the gNB to the wireless device, and the reception of the response signals from the wireless device on uplink (UL), is often performed using relatively wide antenna beams associated with reduced gain compared to the more narrow beams.

[0005] EP 1 050 923 A2 discloses how to configure a dual-polarized antenna by deriving sets of beamforming weights for transmitting and receiving according to two polarizations.

[0006] It is desired to improve performance of wireless communication systems during the initial access procedure.

[0007] Some communication sessions are of limited time duration and will use the wide beams for the entire communication session, since the overhead associated with setting up a higher gain beam may be significant. It is also desired to improve communication conditions for such wireless devices.

SUMMARY

[0008] It is an object of the present disclosure to provide a method, an antenna array control unit, a computer program and a dual polarized antenna array which alleviate at least some of the above-mentioned issues.

[0009] The invention is defined by the appended independent claims. Further embodiments are defined by the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The present disclosure will now be described in more detail with reference to the appended drawings, where:

Figure 1	shows an example wireless access network;
Figures 2A-B	show some example dual polarized antenna arrays comprising antenna elements;
Figures 3-5	are graphs illustrating antenna directivity vs azimuth angle;
Figure 6	schematically illustrates an antenna feed network configured for transmit operations;
Figure 7	schematically illustrates an antenna feed network configured for receive operations;
Figure 8	shows a flowchart illustrating methods;
Figure 9	schematically illustrates processing circuitry; and
Figure 10	shows a computer program product.

DETAILED DESCRIPTION

[0011] Aspects of the present disclosure will now be described more fully hereinafter with reference to the accompanying drawings. The different devices, systems, computer programs, computer program products and methods disclosed herein can, however, be realized in many different forms and should not be construed as being limited to the aspects set forth herein. Like numbers in the drawings refer to like elements throughout.

[0012] The terminology used herein is for describing aspects of the disclosure only and is not intended to limit the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

[0013] Figure 1 schematically illustrates a wireless access network 100 where an access point 110 or transmission point (TRP) is arranged to communicate with a wireless device 120 via an antenna.

[0014] The TRP comprises some sort of phased antenna array 111, or even an advanced antenna system (AAS), configured for generating one or more antenna patterns, where each antenna pattern comprises one or more antenna beams. The antenna array is arranged to be controlled by an antenna array control unit 115 which is only schematically illustrated in Figure 1. This antenna array control unit may be connected 116 to other network resources and processing units deployed remotely from the antenna array, such as one or more cloud-based computing platforms or the like. The AAS may comprise co-located antenna elements or antenna elements that are spatially distributed from each other, e.g., as part of a coordinated multipoint (CoMP) transmission system.

[0015] The antenna array 111 is arranged to generate both wide beams 130 and more narrow beams 140. The wide beams cover a larger portion of the service area of the TRP in terms of angle but is normally associated with a reduced gain compared to the more narrow beams 140. As mentioned above, the wide beams may be used during initial synchronization between the access network and the wireless device 120, such as during transmission of the synchronization signal block (SSB) to the wireless device 120, according to 3GPP TS 38.211. However, the wide beams can also be used for other purposes such as during communication sessions where only a few short data packets are exchanged between the TRP 110 and the wireless device 120. For instance, in case the wireless access network 100 is a 3GPP defined network the communication over the wide beam on uplink may also comprise any of a physical random access channel (PRACH) message, an msg3 message or radio resource control connection request, a channel state information (CSI) report, a physical uplink shared channel (PUSCH) message, and/or a physical uplink control channel (PUCCH) message. Downlink transmissions over the wide beam may comprise any of a tracking reference signal (TRS), a physical downlink control channel (PDCCH) message, a random access response (RAR) message, and/or a contention resolution message.

[0016] According to some aspects, the wide beam 130 is associated with an antenna power pattern which spans an angular interval between 10-40 degrees, and preferably about 15-30 degrees in azimuth and/or elevation. The techniques disclosed herein are most advantageously applied in combination with wider beams, such as beams wider than say 15 degrees, and it is appreciated that there is no distinct upper limit on beam width associated with the proposed methods.

[0017] Figures 2A and 2B schematically illustrate some example dual polarized antenna arrays 200a, 200b with antenna elements 210, 220 of different polarizations. These antenna elements can be arranged in dual polarized arrays aligned with some centrum line C as illustrated in Figure 2A, or the antenna elements can be arranged in single polarized arrays as shown in the example in Figure 2B. The elements of an array are normally aligned with respect to a centrum line C, but this is not a requirement - many different element geometries can be considered. The single polarized arrays may be offset O with respect to each other. It is appreciated that the techniques disclosed herein are not limited to any particular form or geometry of antenna array, in particular, the herein disclosed techniques are applicable to antenna arrays with any number of columns, not just single or double column antenna arrays. An antenna feed network 230 connects the antenna elements 210, 220 to antenna ports 240, 250, sometimes referred to as panel ports. There may, in general, be any number of ports for a single antenna array.

[0018] It is appreciated that antenna arrays may comprise analog components for interconnecting antenna elements with antenna ports to a varying degree, with a varying number of radio transceiver chains connected to the antenna elements. An antenna port may be a physical port connected to antenna elements via an analog network. An antenna port may also be a virtual antenna port defined in software. Some antenna arrays may even comprise full transceiver chains for each antenna element and thus comprise a large number of physical antenna ports which then can be freely combined into various virtual antenna ports. Thus, the concept of an antenna port may comprise both physical antenna ports, i.e., with physical connectors, or virtual antenna ports defined in software, or combinations thereof. The concept of an antenna port is thus to be interpreted broadly herein.

[0019] A transceiver arrangement 260 is connected to the antenna array via the antenna ports 240, 250. The antenna ports may be labelled as a first receive antenna port RX1 and as a second receive antenna port RX2 which can be arranged to have mutually orthogonal polarizations.

[0020] It is appreciated that some cross-polarization leakage may occur, and that perfectly orthogonally polarized antenna ports are difficult to generate in practice. Normally, a cross-polarization discrimination (XPD) on the order of about 25 dB must be tolerated.

[0021] It is also appreciated that the herein disclosed techniques do not rely on any particular form of transceiver, nor is any particular form of modulation, encoding or decoding of transmitted and received signals assumed.

[0022] In a radio antenna pattern, the half power beam width is often defined as the angle between the half-power (-3 dB) points of the main lobe, when referenced to the peak effective radiated power of the main lobe. Beam width is usually but not always expressed in degrees for the horizontal plane (azimuth), but beam width in terms of elevation may also be relevant. Other measures of beam width can also be used, such as the angular span which comprises a given percentage of radiated energy.

[0023] According to the IEEE Standard 145-2013, the directivity of an antenna in a given direction is the ratio of the radiation intensity in the given direction from the antenna to the radiation intensity averaged over all other directions. The average radiation intensity is normally set equal to the total power radiated by the antenna divided by 4π. If the direction is not specified, then the direction of maximum radiation intensity is implied.

[0024] The gain of an antenna in a given direction is the ratio of the radiation intensity in a given direction to the radiation intensity that would be produced if the power accepted by the antenna were isotropically radiated. Gain is normally defined as not including losses arising from impedance and polarization mismatches and does not depend on the system to which the antenna is connected. The radiation intensity of an antenna corresponding to the isotropically radiated power is equal to the power accepted by the antenna divided by 4π. If an antenna is without dissipative loss, then in any given direction its gain is equal to its directivity.

[0025] A partial gain of an antenna for a given polarization in a given direction, is that part of the radiation intensity corresponding to a given polarization divided by the radiation intensity that would be obtained if the power accepted by the antenna were isotropically radiated. The total gain of an antenna in a specified direction is the sum of the partial gains for any two orthogonal polarizations.

[0026] A beamforming weight is a (normally complex) coefficient which multiples a signal component prior to transmission from an antenna element (or after reception). beamforming weights may be grouped into beamforming weight vectors. An antenna element is herein assumed connected to a port if the respective beamforming weight is non-zero. A set of beamforming weights, i.e., a weight vector, is sometimes referred to as a virtualization.

[0027] In 3GPP NR, the SSB block is transmitted, for each given time instant, over a single antenna port, see, e.g., 3GPP TS 38.211, v. 16.1.0, section 8.4.3. The virtualization (or beamforming weights) for that antenna port is, at least in some cases, based on dual polarization beam forming (DPBF) for purposes of efficient use of power amplifier resources. Aspects of the technique was discussed in, e.g., EP3507915A1, US20170352953A1, and EP3507915A1. DPBF is known in general and will therefore not be discussed in more detail herein.

[0028] The DPBF beamforming weights define the connections between an antenna port and antenna elements having two orthogonal or at least different polarizations. Note that an antenna port here may be a panel port of the antenna array, or some form of physical antenna port, or a virtual antenna port defined in software such as a virtualization. The beamforming weight vectors w consists of two parts where a first beamforming weight vector, w_A, defines the connection between a first antenna port and elements having polarization A. Similarly, a second beamforming weight vector, w_B, defines the connection between a second antenna port and elements having polarization B, i.e., $w = \begin{bmatrix} w_A \\ w_B \end{bmatrix}$.

[0029] Sometimes, the same virtualization as used for transmission of, e.g., the SSB is used also for reception of the SSB measurement report (as well as for reception of PRACH, Msg3, Contention Resolution Message and beam report of initial P2 beam sweep, i.e., for DL beam management in a 3GPP defined network. It is also possible that the SSB beam will be used for the full data session for wireless devices with small packages, since it might not be worth to perform a P2 beam sweep for such wireless devices (since it requires additional overhead and latency). In this case, it is expected that the beamforming weights associated with transmission of the SSB beam will be used for reception of the data transmissions (and associated UL signals) as well.

[0030] Figures 3-5 are graphs 300, 400, 500 illustrating example antenna patterns in terms of antenna directivity (measured in dBi) vs azimuth angle in degrees. These graphs illustrate symmetric and even antenna patterns. It is, however, appreciated that the methods disclosed herein are also applicable to more uneven antenna power patterns comprising more than one direction associated with increased antenna gain. Thus, the antenna power pattern 310 may comprise one or more lobes, i.e., high gain directions, of varying width.

[0031] Figure 3 illustrates directivity 300 for each of two example panel ports, e.g., as schematically illustrated in Figures 2A and 2B. The two polarizations are here referred to as polarization A 320 (pol A) and polarization B 330 (pol B). The directivity for the antenna port, shown as 'Total' 310 in Figure 3, is plotted under the assumption that the antenna ports are fed with equal power.

[0032] However, as can be seen from the example, the directivity for individual polarizations 320, 330 may fluctuate significantly with azimuth angle whereas the directivity for the antenna port 310 (defined by the beamforming weight vectors w) does not show such fluctuations but rather the desired beam shape. This antenna port is suitable for transmission since it generates an even and wide antenna beam.

[0033] The antenna power pattern 310 in Figure 3 is an example of a desired antenna power pattern. It is appreciated that this antenna power pattern may be adapted to basically any desired antenna pattern. The antenna power pattern 310 may, e.g., be configured in dependence of a desired coverage area of the antenna array 111, 200a, 200b.

[0034] The fluctuations for individual polarizations result in that the received power, in each direction, despite diversity reception on two receive ports may vary a lot depending on the polarization state of the received signal. This is exemplified in Figure 4 which illustrates directivity normalized beam patterns 400 for the two polarizations (pol A and pol B) as well as the resulting power gain (indicated by dashed lines 410, 420, 430) depending on the polarization of the received signal for five different cases assuming maximum ratio combining reception of the signal (MRC).

[0035] The polarization in the example 400 for the received signal has been varied such that the fraction of received power in the first polarization (pol A) ranges from 0 to 1.00 and correspondingly from 1.00 to 0 for the second polarization (pol B), in steps of 0.25. As can be seen there is a risk that the received power is very low due to polarization mismatch. Note that for some power relations, A/B = 0/1 and 1/0, the received power curve coincides with either of the pol A or pol B curves.

[0036] To summarize, Figure 4 shows an example of directivity for the antenna ports (pol A and pol B) and directivity for the antenna port assuming five different splits of power between the antenna ports due to variation in the polarization state of the impinging wave.

[0037] A main concept of the herein disclosed techniques relates to the generation of at least two sets of virtualizations (or beam forming weight vectors) by means of DPBF. A first set with a single antenna port, used for transmission, and the second set with two antenna ports used for reception. All three antenna ports have substantially identical power patterns and the two antenna ports in the second set are orthogonally or at least differently polarized. The virtualizations are based on an "array expansion technique" which enables different virtualizations to have identical power patterns despite these are connected to different number of antenna elements. This way a power efficient transmit beam is generated by the transmit port, and full-fledged diversity reception can be exploited using the signals on the two orthogonally polarized receiver ports.

[0038] One of the advantages of the invention is that the transceiver 260 becomes insensitive to the polarization of the signals received from the wireless device 120 on the uplink (UL), resulting in that the received power is effectively the same no matter the polarization state of the UL signal. By that, the fluctuations with azimuth angle as shown in the example of Figure 4 will be less pronounced and may even be removed entirely by signal processing in the transceiver 260.

[0039] According to an example, the herein proposed scheme includes the design of two sets of beamforming weight vectors, one set used for transmission of signals to the wireless device 120 and one set used for reception of signals from the wireless device 120.

[0040] According to an example, the DPBF beamforming weight vector used for transmission is defined by

$$w_{TX} = \begin{bmatrix} w_A \\ w_B \end{bmatrix}$$

[0041] Where w_A defines the beamforming weight vector applied to panel elements of polarization A and w_B defines the beamforming weight vector applied to panel elements of polarization B, where polarization A is different or even orthogonal to polarization B.

[0042] For a sufficiently large array, in the example herein four dual-polarized columns, the beamforming weights used for transmission can, via an expansion technique, be based on beamforming weights for a smaller number of elements.

[0043] The procedure will now be exemplified for a one dimensional uniform linear array (ULA) but is equally applicable for a uniform rectangular array (URA), i.e., a two-dimensional array. The herein disclosed techniques may also be generalized to other forms of antenna array geometries in a straight-forward manner.

[0044] An element numbering convention is indicated in Figure 2A and 2B, here in two dimensions, i.e., rows R and columns C (R,C) for an array of size 4x2. The same numbering convention applies for both polarizations in Figure 2A. Note that the total number of antenna elements N is the total number of antenna elements in the array, i.e., with R rows and C columns of dual polarized antenna elements, the total number of elements is N=2RC. Consequently, for Figure 2B, N=16.

[0045] Start by defining a beam weight vector, w_{RX1}, for a first receive port using only half of the array, in this case N/2 elements for an array with a total of N elements

$$w_{RX1o} = \begin{bmatrix} w_{A1o} \\ w_{B1o} \end{bmatrix}$$

[0046] This weight vector defines the desired antenna power pattern which will be generated both by the transmit port as well as by the receive ports. A wide beam may be desired, e.g., for transmission of the SSB in a 3GPP network, but other antenna power patterns may just as well be generated by adapting w_{RX1o} by laboratory experiment or by computer simulation to the desired antenna power pattern. The desired antenna pattern may comprise one or more directions associated with increased gain. The desired antenna pattern may also comprise one or more directions associated with reduced gain, for instance in order to reduce co-cell interference in some directions.

[0047] The weight vector w_{RX1o} is then zero padded, with vector z of size N/2 x 1, to contain as many elements as there is antenna elements, resulting in

$$w_{RX1} = \begin{bmatrix} w_{A1} \\ w_{B1} \end{bmatrix}$$

where

$$w_{A1} = \begin{bmatrix} w_{A1o} \\ z \end{bmatrix}$$

and

$$w_{B1} = \begin{bmatrix} w_{B1o} \\ z \end{bmatrix}.$$

[0048] The next step is to design a second beam weight vector, for a second receive port, with the same power pattern but orthogonal polarization according to

$$w_{RX2} = \begin{bmatrix} Jw_{B1}^* \\ -Jw_{A1}^* \end{bmatrix}$$

where J denotes the exchange matrix (also known as the reverse identity matrix) and where ()* denotes complex conjugate. Finally, the beam weight vector to be used for the transmit port is defined as the sum of the two weight vectors

$$w_{TX1} = w_{RX1} + w_{RX2} = \begin{bmatrix} w_{A1} + Jw_{B1}^* \\ w_{B1} - Jw_{A1}^* \end{bmatrix} = \begin{bmatrix} w_{A1o} \\ Jw_{B1o}^* \\ w_{B1o} \\ -Jw_{A1o}^* \end{bmatrix}.$$

[0049] Note that the matrix J is not the same size matrix on the two sides of the equality sign. To the left the dimension of J is N/2 x N/2 and to the right the dimension of J is N/4 x N/4. Note also that w_{RX1} and w_{RX2} both contain zeros in complementary positions, such that the sum of the weight vectors is rather to be seen as a combination of the weight vectors. Note also that the minus sign in $-Jw_{A1o}^*$ represents a phase shift of π radians, which phase shift can be arbitrarily distributed between the two polarizations and over the elements.

[0050] To arrive at corresponding equations for an URA, define weight matrices for polarizations A, W_{A1o}, and B, W_{B1o}, for a first receive port as matrices of size R x C, with R being the number of element rows and C being the number of element columns. Then convert these matrices to vectors by $w_{A1o} = \text{vec}(W_{A1o})$ and $w_{B1o} = \text{vec}(W_{B1o})$, where vec(), is the vectorize operation, after which the same equations as for the ULA discussed above applies.

[0051] Figure 5 presents an example 500 of the antenna patterns according to the example discussed above. Again, note that 'Total' here represents the directivity for the "antenna port" assuming that receive beam 1 has the same pattern for the first polarization (pol A) as receive beam 2 has for the second polarization (pol B). Receive beam 1 has the same antenna pattern for the second polarization (pol B) as receive beam 2 has for the first polarization (pol A). Thus, the two receive beams have the same patterns but orthogonal or at least significantly different polarizations.

[0052] To summarize, there has been disclosed herein a dual polarized antenna array comprising antenna elements 210, 220 of a first polarization (pol A) and of a second polarization (pol B). Each antenna element is associated with a respective beamforming weight vector for communication with a wireless device 120.

[0053] The antenna array comprises a configurable antenna feed network 230 which is arranged to provide a transmit antenna port TX by configuring a first set of beamforming weight vectors w_{TX1} connecting the transmit port TX to antenna elements of the first and of the second polarization. The transmit antenna port TX is associated with an antenna power pattern 310.

[0054] The antenna feed network 230 is also arranged to provide a first receive antenna port RX1 and a second receive antenna port RX2 by configuring a second set of beamforming weights w_{RX1} connecting the first receive antenna port RX1 to antenna elements of the first and of the second polarization, and a third set of beamforming weights w_{RX2}

connecting the second receive antenna port RX2 to antenna elements of the first and of the second polarization. Each of the receive antenna ports RX1, RX2 is associated with the antenna power pattern 310, i.e., the same antenna pattern as the TX port, and the receive antenna ports RX1, RX2 have different polarizations.

[0055] Figure 6 schematically illustrates an example antenna array 200c configured for transmission via a single transmit port (TX). The feed network 230 here connects the first panel port 240 to elements of the first polarization (pol A) via beamforming weight vectors w_{A1o} and Jw_{B1o}^{*}. The feed network 230 also connects the second panel port 250 to elements of the second polarization (pol B) via beamforming weight vectors w_{B1o} and $-Jw_{A1o}^{*}$. Note that the feed network 230 may be an analogue feed network, or a digital feed network implemented in software, or a combination thereof.

[0056] Figure 7 shows the example antenna array 200d now configured for reception. In order to switch between transmit and receive beams there is a need to reconfigure the feed network 230 (change virtualizations or beamforming weights). This is not only a matter of changing beamforming weights within a polarization but also to be able to connect between polarizations.

[0057] According to some aspects, the feed network 230 of the antenna array 200d is configured for reception by changing associations between antenna ports of the antenna array and antenna elements of both the first and of the second polarization, compared to the configuration of the feed network for the antenna array 200c when configured for transmission.

[0058] According to some other aspects, the antenna arrays 111, 200a, 200b, 200c, 200d discussed herein comprises N/2 antenna elements of the first polarization pol A and N/2 antenna elements of the second polarization pol B. The transmit antenna port TX is connected to all N antenna elements, the first receive antenna port RX1 is connected to N/2 antenna elements out of the N elements, and the second receive antenna port RX2 is connected to the remaining N/2 antenna elements.

[0059] According to some further aspects, the antenna array 111, 200a, 200b, 200c, 200d comprises N/2 antenna elements of the first polarization pol A and N/2 antenna elements of the second polarization pol B. The transmit antenna port TX is connected to all N antenna elements, and wherein the first and second receive antenna ports RX1, RX2 are both connected to all N antenna elements.

[0060] Figure 8 shows a flowchart illustrating methods which summarize the discussions above. In particular, Figure 8 illustrates a method of configuring a dual polarized antenna array 111, 200a, 200b, 200c, 200d for communication between a wireless device 120 and a wireless access network 100, such as exemplified and discussed above in connection to Figure 1. The antenna array 111, 200a, 200b, 200c, 200d comprises antenna elements 210, 220 with respective polarizations, where each antenna element is associated with a respective beamforming weight, e.g., as exemplified in Figures 2A and 2B.

[0061] The disclosed method comprises configuring S1 the antenna array 111, 200a, 200b, 200c, 200d for transmission by a first set of beamforming weights w_{TX1}, wherein the first set of beamforming weights, i.e., a beamforming vector, is arranged to provide a transmit antenna port TX connected to antenna elements of a first polarization pol A and of a second polarization pol B, wherein the transmit antenna port TX is associated with an antenna power pattern 310. The transmit port uses elements of both polarizations 320, 330 to generate an antenna power pattern 310, e.g., as exemplified in Figure 3. Although the powers transmitted in the two polarizations fluctuate over beam angle, the sum of the two is relatively even, which in this case is as desired. However, as discussed above, any antenna power pattern may be used as base for the disclosed methods.

[0062] The method also comprises transmitting S2 a first signal via the transmit antenna port TX on a downlink (DL) from the antenna array 111, 200a, 200b, 200c, 200d to the wireless device 120.

[0063] The method furthermore comprises configuring S3 the antenna array 111, 200a, 200b, 200c, 200d for reception by a second w_{RX1} and a third w_{RX2} set of beamforming weights, i.e., beamforming vectors. The second set of beamforming weights w_{RX1} is arranged to provide a first receive antenna port RX1 connected to antenna elements of the first and of the second polarization, and the third set of beamforming weights w_{RX2} is arranged to provide a second receive antenna port RX2 connected to antenna elements of the first and of the second polarization, where each of the receive antenna ports RX1, RX2 is associated with the antenna power pattern 310, and where the receive antenna ports RX1, RX2 have different polarizations. Notably, both receive ports are associated with the same antenna power pattern 310, which is also the antenna power pattern associated with the single transmit port.

[0064] The method comprises receiving S4 a second signal on an uplink (UL) from the wireless device 120 to the antenna array 111, 200a, 200b, 200c, 200d, via the first receive antenna port RX1 and the second receive antenna port RX2. Thus, diversity reception is enabled, since the two receive ports are of different polarizations. This means that the propagation channel between the wireless device 120 and the antenna array, in combination with the polarization state of the signal transmitted from a wireless device, can attenuate polarizations differently, which can be accounted for at the receiver, e.g., by applying MRC reception or the like.

[0065] The antenna power pattern 310 used for both transmission and reception may be an evenly distributed wide beam as discussed above. However, in some cases, other antenna power patterns may be desired. For instance, an antenna power pattern may be designed to cover some specific geographical region or part of a building. In other words, according to aspects, the configuring for transmission comprises configuring S12 the antenna power pattern in dependence of a desired coverage area of the first signal.

[0066] According to other aspects, the wireless access network 100 is a 3GPP defined network, and the transmitting comprises transmitting S21 a first signal comprising any of a synchronization signal block (SSB) signal, a tracking reference signal (TRS), a physical downlink control channel (PDCCH) message, a random access response (RAR) message, and/or a contention resolution message. Thus, it is appreciated that the herein disclosed techniques can be applied with advantage for the transmission of a number of different types of signals. Similarly, according to aspects, the wireless access network 100 is a 3GPP defined network, and the receiving comprises receiving S41 a second signal comprising any of an SSB response signal, a physical random access channel (PRACH) message, an msg3 message or radio resource control connection request, a channel state information (CSI) report, a physical uplink shared channel (PUSCH) message, and/or a physical uplink control channel (PUCCH) message.

[0067] According to some aspects, the configuring for reception comprises configuring S31 the first receive antenna port RX1 and the second receive antenna port RX2 to have mutually orthogonal polarizations. Configuring receive ports to have substantially orthogonal polarizations may improve receive conditions, which is an advantage. However, it is noted that it is not a requirement to have exactly orthogonal polarizations. Most of the advantages mentioned herein associated with the disclosed methods and devices are obtained also for sufficiently different polarizations on the two receive ports.

[0068] According to some other aspects, the configuring for reception comprises configuring S32 a feed network 230 of the antenna array 111, 200a, 200b, 200c, 200d by changing associations between antenna ports of the antenna array and antenna elements of both the first and of the second polarization. These aspects set the disclosed methods apart from the prior art in that the feed network configuring from transmit to receive mode of operation is not only a matter of changing beamforming weights within a polarization but also a matter of changing connections between polarizations. This also means that the panel ports according to the current disclosure are not only connected to antenna elements having the same polarization, but to elements of both polarizations.

[0069] According to aspects, the method comprises combining S5 the second signal received via the first receive antenna port RX1 with the second signal received via the second receive antenna port RX2. The combining is based on a received signal quality on the first receive antenna port RX1 in relation to a received signal quality on the second receive antenna port RX2. Received signal quality may, e.g., comprise a signal to noise ratio (SNR), a signal to interference and noise ratio (SINR), or a received power metric such as received signal strength (RSS). One example of this type of combining is maximum ratio combining (MRC), and a wide variety of other applicable receive algorithms are also known.

[0070] According to some aspects, the antenna array 111, 200a, 200b, 200c, 200d comprises N/2 antenna elements of the first polarization pol A and N/2 antenna elements of the second polarization pol B. The method comprises connecting S13 the transmit antenna port TX to all N antenna elements, connecting the first receive antenna port RX1 to N/2 antenna elements out of the N elements, and connecting the second receive antenna port RX2 to the remaining N/2 antenna elements.

[0071] According to some other aspects, the method comprises defining S14 the power pattern 310 by N/2 beamforming weights $\begin{bmatrix} w_{A1o} \\ w_{B1o} \end{bmatrix}$, where w_{A1o} represents N/4 beamforming weights associated with antenna elements of the first polarization, and where w_{B1o} represents N/4 beamforming weights associated with antenna elements of a second polarization, wherein the second set of beamforming weights w_{RX1} is given by $w_{RX1} = \begin{bmatrix} w_{A1} \\ w_{B1} \end{bmatrix}$, where $w_{A1} = \begin{bmatrix} w_{A1o} \\ z \end{bmatrix}, w_{B1} = \begin{bmatrix} w_{B1o} \\ z \end{bmatrix}$, and where z is an all-zero vector of length N/4, wherein the third set of N/2 beamforming weights w_{RX2} is given by $w_{RX2} = \begin{bmatrix} e^{j\varphi} J w_{B1}^* \\ e^{j\varphi+\pi} J w_{A1}^* \end{bmatrix}$, where φ represents an arbitrary phase, ()* denotes complex conjugate, and where J represents an N/2 by N/2 reverse identity matrix, and wherein the first set of beamforming weights w_{TX1} is given by

$$w_{TX1} = w_{RX1} + w_{RX2} = \begin{bmatrix} w_{A1} + e^{j\varphi} J w_{B1}^* \\ w_{B1} + e^{j\varphi+\pi} J w_{A1}^* \end{bmatrix} = \begin{bmatrix} w_{A1o} \\ e^{j\varphi} J w_{B1o}^* \\ w_{B1o} \\ e^{j\varphi+\pi} J w_{A1o}^* \end{bmatrix}.$$

[0072] Figure 9 schematically illustrates, in terms of a number of functional units, the components of a control unit 900 according to embodiments of the discussions herein. The control unit may, e.g., form part of an antenna array control unit 115 or a beamforming network controller for controlling a beamforming network such as the antenna feed network 230 discussed in connection to Figrues 2A and 2B.

[0073] Processing circuitry 910 is provided using any combination of one or more of a suitable central processing unit CPU, multiprocessor, microcontroller, digital signal processor DSP, etc., capable of executing software instructions stored in a computer program product, e.g. in the form of a storage medium 930. The processing circuitry 910 may further be provided as at least one application specific integrated circuit ASIC, or field programmable gate array FPGA. The processing circuitry thus comprises a plurality of digital logic components.

[0074] Particularly, the processing circuitry 910 is configured to cause the system 130 to perform a set of operations, or steps. For example, the storage medium 930 may store the set of operations, and the processing circuitry 910 may be configured to retrieve the set of operations from the storage medium 930 to cause the system 130 to perform the set of operations. The set of operations may be provided as a set of executable instructions. Thus, the processing circuitry 910 is thereby arranged to execute methods as herein disclosed.

[0075] The storage medium 930 may also comprise persistent storage, which, for example, can be any single one or combination of magnetic memory, optical memory, solid state memory or even remotely mounted memory.

[0076] The sensor signal processing system 130 further comprises an interface 920 for communications with at least one external device. As such the interface 920 may comprise one or more transmitters and receivers, comprising analogue and digital components and a suitable number of ports for wireline communication.

[0077] The processing circuitry 910 controls the general operation of the system 130, e.g. by sending data and control signals to the interface 920 and the storage medium 930, by receiving data and reports from the interface 920, and by retrieving data and instructions from the storage medium 930. Other components, as well as the related functionality, of the control node are omitted in order not to obscure the concepts presented herein.

[0078] Figure 10 shows a computer program product 1000 comprising computer executable instructions 1010 stored on media 1010 to execute any of the methods disclosed herein.

[0079] The computer program 1020 may be set up for configuring a dual polarized antenna array 111, 200a, 200b, 200c, 200d for communication between a wireless device 120 and a wireless access network 100, wherein the antenna array 111, 200a, 200b, 200c, 200d comprises antenna elements 210, 220 with respective polarizations, and where each antenna element is associated with a respective beamforming weight, the computer program 1020 comprising computer code which, when run on an antenna array control unit 900, causes the antenna array to configure S1 the antenna array 111, 200a, 200b, 200c, 200d for transmission by a first set of beamforming weights w_{TX1}, wherein the first set of beam-forming weights is arranged to provide a transmit antenna port TX connected to antenna elements of a first polarization pol A and of a second polarization pol B, wherein the transmit antenna port TX is associated with an antenna power pattern 310, transmit S2 a first signal via the transmit antenna port TX on a downlink (DL) from the antenna array 111, 200a, 200b, 200c, 200d to the wireless device 120, configure S3 the antenna array 111, 200a, 200b, 200c, 200d for reception by a second w_{RX1} and a third w_{RX2} set of beamforming weights, wherein the second set of beamforming weights w_{RX1} is arranged to provide a first receive antenna port RX1 connected to antenna elements of the first and of the second polarization, wherein the third set of beamforming weights w_{RX2} is arranged to provide a second receive antenna port RX2 connected to antenna elements of the first and of the second polarization, where each of the receive antenna ports RX1, RX2 is associated with the antenna power pattern 310, and where the receive antenna ports RX1, RX2 have different polarizations; and to receive S4 a second signal on an uplink, UL, from the wireless device 120 to the antenna array 111, 200a, 200b, 200c, 200d, via the first receive antenna port RX1 and the second receive antenna port RX2.

Claims

1. A method of configuring a dual polarized antenna array (111, 200a, 200b, 200c, 200d) for communication in a wireless access network (100), the antenna array (111, 200a, 200b, 200c, 200d) comprising antenna elements (210, 220) with respective polarizations and an antenna feed network (230), where each antenna element is associated with a respective beamforming weight, the method comprising

configuring (S1) the antenna array (111, 200a, 200b, 200c, 200d) for transmission by a first set of beamforming weights w_{TX1}, wherein the first set of beamforming weights is arranged, via the antenna feed network (230), to provide a transmit antenna port (TX) connected to antenna elements of a first polarization (pol A) and of a second polarization (pol B), wherein the transmit antenna port (TX) is associated with an antenna power pattern (310), wherein the respective directivities of the first and the second polarizations vary differently along the antenna power pattern associated with the transmit antenna port;
transmitting (S2) a first signal via the transmit antenna port (TX) on a downlink, DL, of the wireless access network (100);
configuring (S3) the antenna array (111, 200a, 200b, 200c, 200d) for reception by a second w_{RX1} and a third w_{RX2} set of beamforming weights, wherein the second set of beamforming weights w_{RX1} is arranged, via the antenna feed network (230), to provide a first receive antenna port (RX1) connected to antenna elements of the first and of the second polarization, wherein the third set of beamforming weights w_{RX2} is arranged, via the antenna feed network (230), to provide a second receive antenna port (RX2) connected to antenna elements of the first and of the second polarization, where each of the receive antenna ports (RX1, RX2) is associated with the antenna power pattern (310), wherein the respective directivities of the first and the second polarizations vary differently along the respective antenna power patterns associated with the first and the second receive antenna ports, and where the respective variations of directivities of the first and the second receive antenna ports (RX1, RX2) are different; and
receiving (S4) a second signal on an uplink, UL, of the wireless access network (100), via the first receive antenna port (RX1) and the second receive antenna port (RX2).

2. The method according to claim 1, wherein the configuring comprises configuring (S11) the antenna power pattern as a wide beam pattern spanning an angular interval between 10-40 degrees, and preferably about 15-30 degrees.

3. The method according to claim 1 or 2, wherein the configuring for transmission comprises configuring (S12) the antenna power pattern in dependence of a desired coverage area of the first signal.

4. The method according to any previous claim, wherein the wireless access network (100) is a third generation partnership program, 3GPP, defined network, where the transmitting comprises transmitting (S21) a first signal comprising any of a synchronization signal block, SSB, signal, a tracking reference signal, TRS, a physical downlink control channel, PDCCH, message, a random access response, RAR, message, and/or a contention resolution message.

5. The method according to any previous claim, wherein the configuring for reception comprises configuring (S31) the first receive antenna port (RX1) and the second receive antenna port (RX2) to have mutually orthogonal polarizations.

6. The method according to any previous claim, wherein the configuring for reception comprises configuring (S32) the feed network (230) of the antenna array (111, 200a, 200b, 200c, 200d) by changing associations between antenna ports of the antenna array and antenna elements of both the first and of the second polarization, compared to the configuration of the feed network for the antenna array when configured for transmission.

7. The method according to any previous claim, wherein the wireless access network (100) is a third generation partnership program, 3GPP, defined network, and where the receiving comprises receiving (S41) a second signal comprising any of an SSB response signal, a physical random access channel, PRACH, message, an msg3 message or radio resource control connection request, a channel state information, CSI, report, a physical uplink shared channel, PUSCH, message, and/or a physical uplink control channel, PUCCH, message.

8. The method according to any previous claim, comprising combining (S5) the second signal received via the first receive antenna port (RX1) with the second signal received via the second receive antenna port (RX2), wherein the combining is based on a received signal quality on the first receive antenna port (RX1) in relation to a received signal quality on the second receive antenna port (RX2).

9. The method according to any previous claim, wherein the antenna array (111, 200a, 200b, 200c, 200d) comprises N/2 antenna elements of the first polarization (pol A) and N/2 antenna elements of the second polarization (pol B), wherein the method comprises connecting (S13) the transmit antenna port (TX) to all N antenna elements, connecting the first receive antenna port (RX1) to N/2 antenna elements out of the N elements, and connecting the second receive antenna port (RX2) to the remaining N/2 antenna elements.

10. The method according to any of claims 1-8 wherein the antenna array (111, 200a, 200b, 200c, 200d) comprises N/2 antenna elements of the first polarization (pol A) and N/2 antenna elements of the second polarization (pol B), wherein the method comprises connecting (S15) the transmit antenna port (TX) to all N antenna elements, and also connecting the first and second receive antenna ports (RX1, RX2) to all N antenna elements.

11. The method according to claim 9, comprising defining (S14) the power pattern (310) by N/2 beamforming weights $\begin{bmatrix} w_{A1o} \\ w_{B1o} \end{bmatrix}$, where w_{A1o} represents N/4 beamforming weights associated with antenna elements of the first polarization, and where w_{B1o} represents N/4 beamforming weights associated with antenna elements of a second polarization, wherein the second set of beamforming weights w_{RX1} is given by $w_{RX1} = \begin{bmatrix} w_{A1} \\ w_{B1} \end{bmatrix}$, where $w_{A1} = \begin{bmatrix} w_{A1o} \\ z \end{bmatrix}, w_{B1} = \begin{bmatrix} w_{B1o} \\ z \end{bmatrix}$, and where z is an all-zero vector of length N/4, wherein the third set of N/2 beamforming weights w_{RX2} is given by $w_{RX2} = \begin{bmatrix} e^{j\varphi} J w_{B1}^* \\ e^{j\varphi+\pi} J w_{A1}^* \end{bmatrix}$, where φ represents an arbitrary phase, ()* denotes complex conjugate, and where J represents an N/2 by N/2 reverse identity matrix, and wherein the first set of beamforming weights w_{TX1} is given by

$$w_{TX1} = w_{RX1} + w_{RX2} = \begin{bmatrix} w_{A1} + e^{j\varphi} J w_{B1}^* \\ w_{B1} + e^{j\varphi+\pi} J w_{A1}^* \end{bmatrix} = \begin{bmatrix} w_{A1o} \\ e^{j\varphi} J w_{B1o}^* \\ w_{B1o} \\ e^{j\varphi+\pi} J w_{A1o}^* \end{bmatrix}$$

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12. The method according to any previous claim, wherein the method is performed by an antenna array control unit (900).

13. An antenna array control unit (115, 900) comprising processing circuitry (910) configured to perform the method according to any of claims 1-12.

14. A computer program (1020) for configuring a dual polarized antenna array (111, 200a, 200b, 200c, 200d) for communication between a wireless device (120) and a wireless access network (100), wherein the antenna array (111, 200a, 200b, 200c, 200d) comprises antenna elements (210, 220) with respective polarizations and an antenna feed network (230), and where each antenna element is associated with a respective beamforming weight, the computer program (1020) comprising computer code which, when run on an antenna array control unit (900), causes the antenna array to:

configure (S1) the antenna array (111, 200a, 200b, 200c, 200d) for transmission by a first set of beamforming weights w_{TX1}, wherein the first set of beamforming weights is arranged, via the antenna feed network (230), to provide a transmit antenna port (TX) connected to antenna elements of a first polarization (pol A) and of a second polarization (pol B), wherein the transmit antenna port (TX) is associated with an antenna power pattern (310), wherein the respective directivities of the first and the second polarizations vary differently along the antenna power pattern associated with the transmit antenna port;
transmit (S2) a first signal via the transmit antenna port (TX) on a downlink, DL, from the antenna array (111, 200a, 200b, 200c, 200d) to the wireless device (120);
configure (S3) the antenna array (111, 200a, 200b, 200c, 200d) for reception by a second w_{RX1} and a third

w_{RX2} set of beamforming weights, wherein the second set of beamforming weights w_{RX1} is arranged, via the antenna feed network (230), to provide a first receive antenna port (RX1) connected to antenna elements of the first and of the second polarization, wherein the third set of beamforming weights w_{RX2} is arranged, via the antenna feed network (230), to provide a second receive antenna port (RX2) connected to antenna elements of the first and of the second polarization, where each of the receive antenna ports (RX1, RX2) is associated with the antenna power pattern (310), wherein the respective directivities of the first and the second polarizations vary differently along the respective antenna power patterns associated with the first and the second receive antenna ports, and where the respective variations of directivities of the first and the second receive antenna ports (RX1, RX2) are different; and to
receive (S4) a second signal on an uplink, UL, from the wireless device (120) to the antenna array (111, 200a, 200b, 200c, 200d), via the first receive antenna port (RX1) and the second receive antenna port (RX2).

15. A computer program product (1000) comprising a computer program (1020) according to claim 14, and a computer readable means (1010) on which the computer program is stored.

16. A dual polarized antenna array (111, 200a, 200b, 200c, 200d) comprising antenna elements (210, 220) of a first polarization (pol A) and of a second polarization (pol B), where each antenna element is associated with a respective beamforming weight for communication with a wireless device (120), the antenna array (111, 200a, 200b, 200c, 200d) comprising a configurable antenna feed network (230),

where the antenna feed network (230) is arranged to provide a transmit antenna port (TX) by configuring a first set of beamforming weights w_{TX1} connecting the transmit port (TX) to antenna elements of the first and of the second polarization, wherein the transmit antenna port (TX) is associated with an antenna power pattern (310), wherein the respective directivities of the first and the second polarizations vary differently along the antenna power pattern associated with the transmit antenna port,
where the antenna feed network (230) is arranged to provide a first receive antenna port (RX1) and a second receive antenna port (RX2) by configuring a second set of beamforming weights w_{RX1} connecting the first receive antenna port (RX1) to antenna elements of the first and of the second polarization, and a third w_{RX2} set of beamforming weights connecting the second receive antenna port (RX2) to antenna elements of the first and of the second polarization,
where each of the receive antenna ports (RX1, RX2) is associated with the antenna power pattern (310), wherein the respective directivities of the first and the second polarizations vary differently along the respective antenna power patterns associated with the first and the second receive antenna ports, and where the respective variations of directivities of the first and the second receive antenna ports (RX1, RX2) are different.

17. The dual polarized antenna array (111, 200a, 200b, 200c, 200d) according to claim 16, wherein the antenna power pattern (310) is a wide beam pattern spanning an angular interval between 10-40 degrees, and preferably about 15-30 degrees.

18. The dual polarized antenna array (111, 200a, 200b, 200c, 200d) according to claim 16 or 17, wherein the antenna power pattern is configured in dependence of a desired coverage area of the antenna array (111, 200a, 200b, 200c, 200d).

19. The dual polarized antenna array (111, 200a, 200b, 200c, 200d) according to any of claims 16-18, wherein the first receive antenna port (RX1) and the second receive antenna port (RX2) are arranged to have mutually orthogonal polarizations.

20. The dual polarized antenna array (111, 200a, 200b, 200c, 200d) according to any of claims 16-19, wherein the feed network (230) of the antenna array (111, 200a, 200b, 200c, 200d) is configured for reception by changing associations between antenna ports of the antenna array and antenna elements of both the first and of the second polarization, compared to the configuration of the feed network for the antenna array when configured for transmission.

21. The dual polarized antenna array (111, 200a, 200b, 200c, 200d) according to any of claims 16-20, wherein the antenna array (111, 200a, 200b, 200c, 200d) comprises N/2 antenna elements of the first polarization (pol A) and N/2 antenna elements of the second polarization (pol B), wherein the transmit antenna port (TX) is connected to all N antenna elements, the first receive antenna port (RX1) is connected to N/2 antenna elements out of the N elements, and the second receive antenna port (RX2) is connected to the remaining N/2 antenna elements.

22. The dual polarized antenna array (111, 200a, 200b, 200c, 200d) according to any of claims 16-21, wherein the antenna array (111, 200a, 200b, 200c, 200d) comprises N/2 antenna elements of the first polarization (pol A) and N/2 antenna elements of the second polarization (pol B), wherein the transmit antenna port (TX) is connected to all N antenna elements, and wherein the first and second receive antenna ports (RX1, RX2) are both connected to all N antenna elements.

Patentansprüche

1. Verfahren zum Konfigurieren einer dual polarisierten Antennenanordnung (111, 200a, 200b, 200c, 200d) zur Kommunikation in einem drahtlosen Zugangsnetzwerk (100), wobei die Antennenanordnung (111, 200a, 200b, 200c, 200d) Antennenelemente (210, 220) mit jeweiligen Polarisationen und ein Antennenspeisenetzwerk (230) umfasst, wobei jedes Antennenelement mit einer jeweiligen Strahlformungsgewichtung assoziiert ist, wobei das Verfahren umfasst

Konfigurieren (S1) der Antennenanordnung (111, 200a, 200b, 200c, 200d) zur Übertragung durch einen ersten Satz von Strahlformungsgewichtungen w_{TX1}, wobei der erste Satz von Strahlformungsgewichtungen mittels des Antennenspeisenetzwerks (230) angeordnet wird, um einen Übertragungsantennenanschluss (TX) bereitzustellen, der mit Antennenelementen einer ersten Polarisation (pol A) und einer zweiten Polarisation (pol B) verbunden ist, wobei der Übertragungsantennenanschluss (TX) mit einem Antennenleistungsdiagramm (310) assoziiert ist, wobei die jeweiligen Richtwirkungen der ersten und der zweiten Polarisation entlang des Antennenleistungsdiagramms, das mit dem Übertragungsantennenanschluss assoziiert ist, unterschiedlich variieren;
Übertragen (S2) eines ersten Signals mittels des Übertragungsantennenanschlusses (TX) auf einer Abwärtsstrecke, DL, des drahtlosen Zugangsnetzwerks (100);
Konfigurieren (S3) der Antennenanordnung (111, 200a, 200b, 200c, 200d) zum Empfang durch einen zweiten w_{RX1} und einen dritten w_{RX2} Satz von Strahlformungsgewichtungen, wobei der zweite Satz von Strahlformungsgewichtungen w_{RX1} mittels des Antennenspeisenetzwerks (230) angeordnet wird, um einen ersten Empfangsantennenanschluss (RX1) bereitzustellen, der mit Antennenelementen der ersten und der zweiten Polarisation verbunden ist, wobei der dritte Satz von Strahlformungsgewichtungen w_{RX2} mittels des Antennenspeisenetzwerks (230) angeordnet wird, um einen zweiten Empfangsantennenanschluss (RX2) bereitzustellen, der mit Antennenelementen der ersten und der zweiten Polarisation verbunden ist, wobei jeder der Empfangsantennenanschlüsse (RX1, RX2) mit dem Antennenleistungsdiagramm (310) assoziiert ist, wobei die jeweiligen Richtwirkungen der ersten und der zweiten Polarisation entlang der jeweiligen Antennenleistungsdiagramme, die mit dem ersten und dem zweiten Empfangsantennenanschluss assoziiert sind, unterschiedlich variieren und wobei die jeweiligen Variationen von Richtwirkungen des ersten und zweiten Empfangsantennenanschlusses (RX1, RX2) unterschiedlich sind; und
Empfangen (S4) eines zweiten Signals auf einer Aufwärtsstrecke, UL, des drahtlosen Zugangsnetzwerks (100) mittels des ersten Empfangsantennenanschlusses (RX1) und des zweiten Empfangsantennenanschlusses (RX2).

2. Verfahren nach Anspruch 1, wobei das Konfigurieren Konfigurieren (S11) des Antennenleistungsdiagramms als ein Breitstrahldiagramm umfasst, das ein Winkelintervall zwischen 10-40 Grad und vorzugsweise etwa 15-30 Grad überspannt.

3. Verfahren nach Anspruch 1 oder 2, wobei das Konfigurieren zur Übertragung Konfigurieren (S12) des Antennenleistungsdiagramms in Abhängigkeit eines gewünschten Abdeckungsbereichs des ersten Signals umfasst.

4. Verfahren nach einem vorstehenden Anspruch, wobei das drahtlose Zugangsnetzwerk (100) ein definiertes Netzwerk des Partnerschaftsprogramms der dritten Generation, definiertes 3GPP-Netzwerk, ist, wobei das Übertragen Übertragen (S21) eines ersten Signals umfasst, das ein beliebiges von einem Signal eines Synchronisationssignalblocks, SSB-Signal, einem Nachvervolgungsreferenzsignal, TRS, einer Nachricht eines physikalischen Abwärtsstrecken-Steuerkanals, PDCCH-Nachricht, einer Direktzugriffantwort-, RAR-, Nachricht, und/oder einer Konfliktauflösungsnachricht umfasst.

5. Verfahren nach einem vorstehenden Anspruch, wobei das Konfigurieren zum Empfang Konfigurieren (S31) des ersten Empfangsantennenanschlusses (RX1) und des zweiten Empfangsantennenanschlusses (RX2) umfasst, um wechselseitig orthogonale Polarisationen aufzuweisen.

6. Verfahren nach einem vorstehenden Anspruch, wobei das Konfigurieren zum Empfang, verglichen mit der Konfiguration des Speisenetzwerks für die Antennenanordnung, wenn zur Übertragung konfiguriert, Konfigurieren (S32) des Speisenetzwerks (230) der Antennenanordnung (111, 200a, 200b, 200c, 200d) durch Ändern von Assoziationen zwischen Antennenanschlüssen der Antennenanordnung und Antennenelementen von sowohl der ersten als auch der zweiten Polarisation umfasst.

7. Verfahren nach einem vorstehenden Anspruch, wobei das drahtlose Zugangsnetzwerk (100) ein definiertes Netzwerk des Partnerschaftsprogramms der dritten Generation, definiertes 3GPP-Netzwerk, ist, und wobei das Empfangen Empfangen (S41) eines zweiten Signals umfasst, das ein beliebiges von einem SSB-Antwortsignal, einer Nachricht eines Direktzugriffskanals, PRACH-Nachricht, einer msg3-Nachricht oder Verbindungsanfrage zur Steuerung von Funkressourcen, einem Bericht von Kanalstatusinformationen, CSI-Bericht, einer Nachricht eines geteilten physikalischen Aufwärtsstreckenkanals, PUSCH-Nachricht, und/oder einer Nachricht eines physikalischen Aufwärtsstrecken-Steuerkanals, PUCCH-Nachricht, umfasst.

8. Verfahren nach einem vorstehenden Anspruch, umfassend Kombinieren (S5) des zweiten Signals, das mittels des ersten Empfangsantennenanschlusses (RX1) empfangen wurde, mit dem zweiten Signal, das mittels des zweiten Empfangsantennenanschlusses (RX2) empfangen wurde, wobei das Kombinieren auf einer Qualität des an dem ersten Empfangsantennenanschluss (RX1) empfangenen Signals in Bezug auf eine Qualität des an dem zweiten Empfangsantennenanschluss (RX2) empfangenen Signals basiert ist.

9. Verfahren nach einem vorstehenden Anspruch, wobei die Antennenanordnung (111, 200a, 200b, 200c, 200d) N/2 Antennenelemente der ersten Polarisation (pol A) und N/2 Antennenelemente der zweiten Polarisation (pol B) umfasst, wobei das Verfahren Verbinden (S13) des Übertragungsantennenanschlusses (TX) mit allen N Antennenelementen, Verbinden des ersten Empfangsantennenanschlusses (RX1) mit N/2 Antennenelementen von den N Elementen und Verbinden des zweiten Empfangsantennenanschlusses (RX2) mit den verbleibenden N/2 Antennenelementen umfasst.

10. Verfahren nach einem der Ansprüche 1-8, wobei die Antennenanordnung (111, 200a, 200b, 200c, 200d) N/2 Antennenelemente der ersten Polarisation (pol A) und N/2 Antennenelemente der zweiten Polarisation (pol B) umfasst, wobei das Verfahren Verbinden (S15) des Übertragungsantennenanschlusses (TX) mit allen N Antennenelementen und ebenfalls Verbinden des ersten und zweiten Empfangsantennenanschlusses (RX1, RX2) mit allen N Antennenelementen umfasst.

11. Verfahren nach Anspruch 9, umfassend Definieren (S14) des Leistungsdiagramms (310) durch N/2 Strahlformungsgewichtungen $\begin{bmatrix} w_{A1o} \\ w_{B1o} \end{bmatrix}$, wobei w_{A1o} N/4 Strahlformungsgewichtungen repräsentiert, die mit Antennenelementen der ersten Polarisation assoziiert sind, und wobei w_{B1o} N/4 Strahlformungsgewichtungen repräsentiert, die mit Antennenelementen einer zweiten Polarisation assoziiert sind, wobei der zweite Satz von Strahlformungsgewichtungen w_{RX1} durch $w_{RX1} = \begin{bmatrix} w_{A1} \\ w_{B1} \end{bmatrix}$ gegeben ist, wobei $w_{A1} = \begin{bmatrix} w_{A1o} \\ z \end{bmatrix}, w_{B1} = \begin{bmatrix} w_{B1o} \\ z \end{bmatrix}$, und wobei z ein Gesamtnullvektor der Länge N/4 ist, wobei der dritte Satz von N/2 Strahlformungsgewichtungen w_{RX2} durch $w_{RX2} = \begin{bmatrix} e^{j\varphi} J w^*_{B1} \\ e^{j\varphi+\pi} J w^*_{A1} \end{bmatrix}$, gegeben ist, wobei φ eine willkürliche Phase repräsentiert, ()* komplexes Konjugat bezeichnet und wobei J eine N/2 mal N/2 Umkehridentitätsmatrix repräsentiert und wobei der erste Satz von Strahlformungsgewichtungen w_{TX1} gegeben ist durch

$$w_{TX1} = w_{RX1} + w_{RX2} = \begin{bmatrix} w_{A1} + e^{j\varphi} J w^*_{B1} \\ w_{B1} + e^{j\varphi+\pi} J w^*_{A1} \end{bmatrix} = \begin{bmatrix} w_{A1o} \\ e^{j\varphi} J w^*_{B1o} \\ w_{B1o} \\ e^{j\varphi} J w^*_{A1o} \end{bmatrix}$$

12. Verfahren nach einem vorstehenden Anspruch, wobei das Verfahren von einer Antennenanordnungssteuerungseinheit (900) durchgeführt wird.

13. Antennenanordnungssteuerungseinheit (115, 900), umfassend Verarbeitungsschaltung (910), die konfiguriert ist, um das Verfahren nach einem der Ansprüche 1-12 durchzuführen.

14. Computerprogramm (1020) zum Konfigurieren einer dual polarisierten Antennenanordnung (111, 200a, 200b, 200c, 200d) zur Kommunikation zwischen einer drahtlosen Vorrichtung (120) und einem drahtlosen Zugangsnetzwerk (100), wobei die Antennenanordnung (111, 200a, 200b, 200c, 200d) Antennenelemente (210, 220) mit jeweiligen Polarisationen und ein Antennenspeisenetzwerk (230) umfasst, und wobei jedes Antennenelement mit einer jeweiligen Strahlformungsgewichtung assoziiert ist, wobei das Computerprogramm (1020) Computercode umfasst, der, wenn auf einer Antennenanordnungssteuerungseinheit (900) ausgeführt, die Antennenanordnung veranlasst:

die Antennenanordnung (111, 200a, 200b, 200c, 200d) zur Übertragung durch einen ersten Satz von Strahlformungsgewichtungen w_{TX1} zu konfigurieren (S1), wobei der erste Satz von Strahlformungsgewichtungen mittels des Antennenspeisenetzwerks (230) angeordnet wird, um einen Übertragungsantennenanschluss (TX) bereitzustellen, der mit Antennenelementen einer ersten Polarisation (pol A) und einer zweiten Polarisation (pol B) verbunden ist, wobei der Übertragungsantennenanschluss (TX) mit einem Antennenleistungsdiagramm (310) assoziiert ist, wobei die jeweiligen Richtwirkungen der ersten und der zweiten Polarisation entlang des Antennenleistungsdiagramms, das mit dem Übertragungsantennenanschluss assoziiert ist, unterschiedlich variieren;
ein erstes Signal mittels des Übertragungsantennenanschlusses (TX) auf einer Abwärtsstrecke, DL, von der Antennenanordnung (111, 200a, 200b, 200c, 200d) an die drahtlose Vorrichtung (120) zu übertragen (S2);
die Antennenanordnung (111, 200a, 200b, 200c, 200d) zum Empfang durch einen zweiten w_{RX1} und einen dritten w_{RX2} Satz von Strahlformungsgewichtungen zu konfigurieren (S3), wobei der zweite Satz von Strahlformungsgewichtungen w_{RX1} mittels des Antennenspeisenetzwerks (230) angeordnet wird, um einen ersten Empfangsantennenanschluss (RX1) bereitzustellen, der mit Antennenelementen der ersten und der zweiten Polarisation verbunden ist, wobei der dritte Satz von Strahlformungsgewichtungen w_{RX2} mittels des Antennenspeisenetzwerks (230) angeordnet wird, um einen zweiten Empfangsantennenanschluss (RX2) bereitzustellen, der mit Antennenelementen der ersten und der zweiten Polarisation verbunden ist, wobei jeder der Empfangsantennenanschlüsse (RX1, RX2) mit dem Antennenleistungsdiagramm (310) assoziiert ist, wobei die jeweiligen Richtwirkungen der ersten und der zweiten Polarisation entlang der jeweiligen Antennenleistungsdiagramme, die mit dem ersten und dem zweiten Empfangsantennenanschluss assoziiert sind, unterschiedlich variieren und wobei die jeweiligen Variationen von Richtwirkungen des ersten und des zweiten Empfangsantennenanschlusses (RX1, RX2) unterschiedlich sind; und um
mittels des ersten Empfangsantennenanschlusses (RX1) und des zweiten Empfangsantennenanschlusses (RX2) ein zweites Signal auf einer Aufwärtsstrecke, UL, von der drahtlosen Vorrichtung (120) an die Antennenanordnung (111, 200a, 200b, 200c, 200d) zu empfangen (S4).

15. Computerprogrammprodukt (1000), umfassend ein Computerprogramm (1020) nach Anspruch 14 und ein Computer-lesbares Mittel (1010), auf dem das Computerprogramm gespeichert ist.

16. Dual polarisierte Antennenanordnung (111, 200a, 200b, 200c, 200d), umfassend Antennenelemente (210, 220) einer ersten Polarisation (pol A) und einer zweiten Polarisation (pol B), wobei jedes Antennenelement mit einer jeweiligen Strahlformungsgewichtung zur Kommunikation mit einer drahtlosen Vorrichtung (120) assoziiert ist, wobei die Antennenanordnung (111, 200a, 200b, 200c, 200d) ein konfigurierbares Antennenspeisenetzwerk (230) umfasst,

wobei das Antennenspeisenetzwerk (230) angeordnet ist, um einen Übertragungsantennenanschluss (TX) durch Konfigurieren eines ersten Satzes von Strahlformungsgewichtungen w_{TX1} bereitzustellen, die den Übertragungsanschluss (TX) mit Antennenelementen der ersten und der zweiten Polarisation verbinden, wobei der Übertragungsantennenanschluss (TX) mit einem Antennenleistungsdiagramm (310) assoziiert ist, wobei die jeweiligen Richtwirkungen der ersten und der zweiten Polarisation entlang des Antennenleistungsdiagramms, das mit dem Übertragungsantennenanschluss assoziiert ist, unterschiedlich variieren,
wobei das Antennenspeisenetzwerk (230) angeordnet ist, um einen ersten Empfangsantennenanschluss (RX1) und einen zweiten Empfangsantennenanschluss (RX2) durch Konfigurieren eines zweiten Satzes von Strahlformungsgewichtungen w_{RX1}, die den ersten Empfangsantennenanschluss (RX1) mit Antennenelementen der ersten und der zweiten Polarisation verbinden, und eines dritten w_{RX2} Satzes von Strahlformungsgewichtungen, die den zweiten Empfangsantennenanschluss (RX2) mit Antennenelementen der ersten und der zweiten Polarisation verbinden, bereitzustellen,
wobei jeder der Empfangsantennenanschlüsse (RX1, RX2) mit dem Antennenleistungsdiagramm (310) assoziiert ist, wobei die jeweiligen Richtwirkungen der ersten und der zweiten Polarisation entlang der jeweiligen

Antennenleistungsdiagramme, die mit dem ersten und dem zweiten Empfangsantennenanschluss assoziiert sind, unterschiedlich variieren, und wobei die jeweiligen Variationen von Richtwirkungen des ersten und des zweiten Empfangsantennenanschlusses (RX1, RX2) unterschiedlich sind.

17. Dual polarisierte Antennenanordnung (111, 200a, 200b, 200c, 200d) nach Anspruch 16, wobei das Antennenleistungsdiagramm (310) ein Breitstrahldiagramm ist, das ein Winkelintervall zwischen 10-40 Grad und vorzugsweise etwa 15-30 Grad überspannt.

18. Dual polarisierte Antennenanordnung (111, 200a, 200b, 200c, 200d) nach Anspruch 16 oder 17, wobei das Antennenleistungsdiagramm in Abhängigkeit eines gewünschten Abdeckungsbereichs der Antennenanordnung (111, 200a, 200b, 200c, 200d) konfiguriert ist.

19. Dual polarisierte Antennenanordnung (111, 200a, 200b, 200c, 200d) nach einem der Ansprüche 16-18, wobei der erste Empfangsantennenanschluss (RX1) und der zweite Empfangsantennenanschluss (RX2) angeordnet sind, um wechselseitig orthogonale Polarisationen aufzuweisen.

20. Dual polarisierte Antennenanordnung (111, 200a, 200b, 200c, 200d) nach einem der Ansprüche 16-19, wobei das Speisenetzwerk (230) der Antennenanordnung (111, 200a, 200b, 200c, 200d) verglichen mit der Konfiguration des Speisenetzwerks für die Antennenanordnung, wenn zur Übertragung konfiguriert, durch Ändern von Assoziationen zwischen Antennenanschlüssen der Antennenanordnung und Antennenelementen von sowohl der ersten als auch der zweiten Polarisation zum Empfang konfiguriert wird.

21. Dual polarisierte Antennenanordnung (111, 200a, 200b, 200c, 200d) nach einem der Ansprüche 16-20, wobei die Antennenanordnung (111, 200a, 200b, 200c, 200d) N/2 Antennenelemente der ersten Polarisation (pol A) und N/2 Antennenelemente der zweiten Polarisation (pol B) umfasst, wobei der Übertragungsantennenanschluss (TX) mit allen N Antennenelementen verbunden ist, der erste Empfangsantennenanschluss (RX1) mit N/2 Antennenelementen von den N Elementen verbunden ist und der zweite Empfangsantennenanschlusses (RX2) mit den verbleibenden N/2 Antennenelementen verbunden ist.

22. Dual polarisierte Antennenanordnung (111, 200a, 200b, 200c, 200d) nach einem der Ansprüche 16-21, wobei die Antennenanordnung (111, 200a, 200b, 200c, 200d) N/2 Antennenelemente der ersten Polarisation (pol A) und N/2 Antennenelemente der zweiten Polarisation (pol B) umfasst, wobei der Übertragungsantennenanschluss (TX) mit allen N Antennenelementen verbunden ist, und wobei der erste und zweite Empfangsantennenanschluss (RX1, RX2) beide mit allen N Antennenelementen verbunden sind.

Revendications

1. Procédé de configuration d'un réseau d'antennes à double polarisation (111, 200a, 200b, 200c, 200d) pour une communication dans un réseau d'accès sans fil (100), le réseau d'antennes (111, 200a, 200b, 200c, 200d) comprenant des éléments d'antenne (210, 220) avec des polarisations respectives et un réseau d'alimentation d'antenne (230), dans lequel chaque élément d'antenne est associé à un poids de formation de faisceau respectif, le procédé comprenant

la configuration (S1) du réseau d'antennes (111, 200a, 200b, 200c, 200d) pour une transmission par un premier ensemble de poids de formation de faisceau w_{TX1}, dans lequel le premier ensemble de poids de formation de faisceau est agencé, par le biais du réseau d'alimentation d'antenne (230), pour fournir un port d'antenne de transmission (TX) raccordé à des éléments d'antenne d'une première polarisation (pol A) et d'une seconde polarisation (pol B), dans lequel le port d'antenne de transmission (TX) est associé à un motif de puissance d'antenne (310), dans lequel les directivités respectives des première et seconde polarisations varient différemment le long du motif de puissance d'antenne associé au port d'antenne de transmission ;
la transmission (S2) d'un premier signal par le biais du port d'antenne de transmission (TX) sur une liaison descendante, DL, du réseau d'accès sans fil (100) ;
la configuration (S3) du réseau d'antennes (111, 200a, 200b, 200c, 200d) pour une réception par un deuxième w_{RX1} et un troisième w_{RX2} ensemble de poids de formation de faisceau, dans lequel le deuxième ensemble de poids de formation de faisceau w_{RX1} est agencé, par le biais du réseau d'alimentation d'antenne (230), pour fournir un premier port d'antenne de réception (RX1) raccordé à des éléments d'antenne de la première et de la seconde polarisation, dans lequel le troisième ensemble de poids de formation de faisceau wRX2 est agencé,

par le biais du réseau d'alimentation d'antenne (230), pour fournir un second port d'antenne de réception (RX2) raccordé à des éléments d'antenne de la première et de la seconde polarisation, dans lequel chacun des ports d'antenne de réception (RX1, RX2) est associé au motif de puissance d'antenne (310), dans lequel les directivités respectives des première et seconde polarisations varient différemment le long des motifs de puissance d'antenne respectifs associés aux premier et second ports d'antenne de réception, et dans lequel les variations respectives de directivités des premier et second ports d'antenne de réception (RX1, RX2) sont différentes ; et la réception (S4) d'un second signal sur une liaison montante, UL, du réseau d'accès sans fil (100), par le biais du premier port d'antenne de réception (RX1) et du second port d'antenne de réception (RX2).

2. Procédé selon la revendication 1, dans lequel la configuration comprend la configuration (S11) du motif de puissance d'antenne en tant que motif à faisceau large couvrant un intervalle angulaire entre 10-40 degrés et, de préférence, autour de 15-30 degrés.

3. Procédé selon la revendication 1 ou 2, dans lequel la configuration pour une transmission comprend la configuration (S12) du motif de puissance d'antenne en fonction d'une zone de couverture souhaitée du premier signal.

4. Procédé selon une quelconque revendication précédente, dans lequel le réseau d'accès sans fil (100) est un réseau défini par un programme de partenariat de troisième génération, 3GPP, dans lequel la transmission comprend la transmission (S21) d'un premier signal comprenant l'un quelconque d'un signal de bloc de signal de synchronisation, SSB, d'un signal de référence de suivi, TRS, d'un message de canal de commande de liaison descendante physique, PDCCH, d'un message de réponse d'accès aléatoire, RAR et/ou d'un message de résolution de contention.

5. Procédé selon une quelconque revendication précédente, dans lequel la configuration pour une réception comprend la configuration (S31) du premier port d'antenne de réception (RX1) et du second port d'antenne de réception (RX2) pour présenter des polarisations mutuellement orthogonales.

6. Procédé selon une quelconque revendication précédente, dans lequel la configuration pour une réception comprend la configuration (S32) du réseau d'alimentation (230) du réseau d'antennes (111, 200a, 200b, 200c, 200d) en changeant des associations entre des ports d'antenne du réseau d'antennes et des éléments d'antenne à la fois de la première et de la seconde polarisation, comparée à la configuration du réseau d'alimentation pour le réseau d'antennes lorsqu'il est configuré pour une transmission.

7. Procédé selon une quelconque revendication précédente, dans lequel le réseau d'accès sans fil (100) est un réseau défini par un programme de partenariat de troisième génération, 3GPP, et dans lequel la réception comprend la réception (S41) d'un second signal comprenant l'un quelconque d'un signal de réponse de signal SSB, d'un message de canal d'accès aléatoire physique, PRACH, d'une demande de connexion de commande de ressource radio ou de message msg3, d'un rapport d'informations d'état de canal, CSI, d'un message de canal partagé de liaison montante physique, PUSCH et/ou d'un message de canal de commande de liaison montante physique, PUCCH.

8. Procédé selon une quelconque revendication précédente, comprenant la combinaison (S5) du second signal reçu par le biais du premier port d'antenne de réception (RX1) avec le second signal reçu par le biais du second port d'antenne de réception (RX2), dans lequel la combinaison est basée sur une qualité de signal reçu sur le premier port d'antenne de réception (RX1) par rapport à une qualité de signal reçu sur le second port d'antenne de réception (RX2).

9. Procédé selon une quelconque revendication précédente, dans lequel le réseau d'antennes (111, 200a, 200b, 200c, 200d) comprend N/2 éléments d'antenne de la première polarisation (pol A) et N/2 éléments d'antenne de la seconde polarisation (pol B), dans lequel le procédé comprend le raccordement (S13) du port d'antenne de transmission (TX) à tous les N éléments d'antenne, le raccordement du premier port d'antenne de réception (RX1) aux N/2 éléments d'antenne parmi les N éléments d'antenne et le raccordement du second port d'antenne de réception (RX2) aux N/2 éléments d'antenne restants.

10. Procédé selon l'une quelconque des revendications 1-8, dans lequel le réseau d'antennes (111, 200a, 200b, 200c, 200d) comprend N/2 éléments d'antenne de la première polarisation (pol A) et N/2 éléments d'antenne de la seconde polarisation (pol B), dans lequel le procédé comprend le raccordement (S15) du port d'antenne de transmission (TX) à tous les N éléments d'antenne, et également le raccordement des premier et second ports d'antenne de réception (RX1, RX2) à tous les N éléments d'antenne.

11. Procédé selon la revendication 9, comprenant la définition (S14) du motif de puissance (310) par N/2 poids de formation de faisceau $\begin{bmatrix} w_{A1o} \\ w_{B1o} \end{bmatrix}$, dans lequel w_{A1o} représente N/4 poids de formation de faisceau associés à des éléments d'antenne de la première polarisation et dans lequel w_{B1o} représente N/4 poids de formation de faisceau associés à des éléments d'antenne d'une seconde polarisation, dans lequel le deuxième ensemble de poids de formation de faisceau w_{RX1} est donné par $w_{RX1} = \begin{bmatrix} w_{A1} \\ w_{B1} \end{bmatrix}$, dans lequel $w_{A1} = \begin{bmatrix} w_{A1o} \\ z \end{bmatrix}, w_{B1} = \begin{bmatrix} w_{B1o} \\ z \end{bmatrix}$, et dans lequel z est un vecteur entièrement nul de longueur N/4, dans lequel le troisième ensemble de N/2 poids de formation de faisceau w_{RX2} est donné par $w_{RX2} = \begin{bmatrix} e^{j\varphi} J w^*{}_{B1} \\ e^{j\varphi+\pi} J w^*{}_{A1} \end{bmatrix}$, dans lequel φ représente une phase arbitraire, ()* signifie un conjugué complexe, et dans lequel J représente une matrice d'identité inverse N/2 par N/2 et dans lequel le premier ensemble de poids de formation de faisceau w_{TX1} est donné par

$$w_{TX1} = w_{RX1} + w_{RX2} = \begin{bmatrix} w_{A1} + e^{j\varphi} J w^*{}_{B1} \\ w_{B1} + e^{j\varphi+\pi} J w^*{}_{A1} \end{bmatrix} = \begin{bmatrix} w_{A1o} \\ e^{j\varphi} J w^*{}_{B1o} \\ w_{B1o} \\ e^{j\varphi} J w^*{}_{A1o} \end{bmatrix}$$

12. Procédé selon une quelconque revendication précédente, dans lequel le procédé est réalisé par une unité de commande de réseau d'antennes (900).

13. Unité de commande de réseau d'antennes (115, 900) comprenant un ensemble de circuits de traitement (910) configuré pour réaliser le procédé selon l'une quelconque des revendications 1-12.

14. Programme informatique (1020) pour configurer un réseau d'antennes à double polarisation (111, 200a, 200b, 200c, 200d) pour une communication entre un dispositif sans fil (120) et un réseau d'accès sans fil (100), dans lequel le réseau d'antennes (111, 200a, 200b, 200c, 200d) comprend des éléments d'antenne (210, 220) avec des polarisations respectives et un réseau d'alimentation d'antenne '230), et dans lequel chaque élément d'antenne est associé à un poids de formation de faisceau respectif, le programme informatique (1020) comprenant un code informatique qui, lorsqu'il est exécuté sur une unité de commande de réseau d'antennes (900), amène le réseau d'antennes à :

configurer (S1) le réseau d'antennes (111, 200a, 200b, 200c, 200d) pour une transmission par un premier ensemble de poids de formation de faisceau w_{TX1}, dans lequel le premier ensemble de poids de formation de faisceau est agencé, par le biais du réseau d'alimentation d'antenne (230), pour fournir un port d'antenne de transmission (TX) raccordé à des éléments d'antenne d'une première polarisation (pol A) et d'une seconde polarisation (pol B), dans lequel le port d'antenne de transmission (TX) est associé à un motif de puissance d'antenne (310), dans lequel les directivités respectives des première et seconde polarisations varient différemment le long du motif de puissance d'antenne associé au port d'antenne de transmission ;
transmettre (S2) un premier signal par le biais du port d'antenne de transmission (TX) sur une liaison descendante, DL, à partir du réseau d'antennes (111, 200a, 200b, 200c, 200d) au dispositif sans fil (120) ;
configurer (S3) le réseau d'antennes (111, 200a, 200b, 200c, 200d) pour une réception par un deuxième w_{RX1} et un troisième w_{RX2} ensemble de poids de formation de faisceau, dans lequel le deuxième ensemble de poids de formation de faisceau w_{RX1} est agencé, par le biais du réseau d'alimentation d'antenne (230), pour fournir un premier port d'antenne de réception (RX1) raccordé à des éléments d'antenne de la première et de la seconde polarisation, dans lequel le troisième ensemble de poids de formation de faisceau w_{RX2} est agencé, par le biais du réseau d'alimentation d'antenne (230), pour fournir un second port d'antenne de réception (RX2) raccordé à des éléments d'antenne de la première et de la seconde polarisation, dans lequel chacun des ports d'antenne de réception (RX1, RX2) est associé au motif de puissance d'antenne (310), dans lequel les directivités respectives des première et seconde polarisations varient différemment le long des motifs de puissance d'antenne respectifs associés aux premier et second ports d'antenne de réception, et dans lequel les variations respectives de directivités des premier et second ports d'antenne de réception (RX1, RX2) sont différentes ; et à

recevoir (S4) un second signal sur une liaison montante, UL, en provenance du dispositif sans fil (120) au réseau d'antennes (111, 200a, 200b, 200c, 200d), par le biais du premier port d'antenne de réception (RX1) et du second port d'antenne de réception (RX2).

15. Produit de programme informatique (1000) comprenant un programme informatique (1020) selon la revendication 14 et un moyen lisible par ordinateur (1010) sur lequel le programme informatique est stocké.

16. Réseau d'antennes à double polarisation (111, 200a, 200b, 200c, 200d) comprenant des éléments d'antenne (210, 220) d'une première polarisation (pol A) et d'une seconde polarisation (pol B), dans lequel chaque élément d'antenne est associé à un poids de formation de faisceau respectif pour une communication avec un dispositif sans fil (120), le réseau d'antennes (111, 200a, 200b, 200c, 200d) comprenant un réseau d'alimentation d'antenne (230),

dans lequel le réseau d'alimentation d'antenne (230) est agencé pour fournir un port d'antenne de transmission (TX) en configurant un premier ensemble de poids de formation de faisceau w_{TX1} raccordant le port de transmission (TX) à des éléments d'antenne de la première et de la seconde polarisation, dans lequel le port d'antenne de transmission (TX) est associé à un motif de puissance d'antenne (310), dans lequel les directivités respectives des première et seconde polarisations varient différemment le long du motif de puissance d'antenne associé au port d'antenne de transmission,

dans lequel le réseau d'alimentation d'antenne (230) est agencé pour fournir un premier port d'antenne de réception (RX1) et un second port d'antenne de réception (RX2) en configurant un deuxième ensemble de poids de formation de faisceau w_{RX1} raccordant le premier port d'antenne de réception (RX1) à des éléments d'antenne de la première et de la seconde polarisation, et un troisième ensemble w_{RX2} de poids de formation de faisceau raccordant le second port d'antenne de réception (RX2) à des éléments d'antenne de la première et de la seconde polarisation,

dans lequel chacun des ports d'antenne de réception (RX1, RX2) est associé au motif de puissance d'antenne (310), dans lequel les directivités respectives des première et seconde polarisations varient différemment le long des motifs de puissance d'antenne respectifs associés aux premier et second ports d'antenne de réception, et dans lequel les variations respectives de directivités des premier et second ports d'antenne de réception (RX1, RX2) sont différentes.

17. Réseau d'antennes à double polarisation (111, 200a, 200b, 200c, 200d) selon la revendication 16, dans lequel le motif de puissance d'antenne (310) est un motif à faisceau large couvrant un intervalle angulaire entre 10-40 degrés et, de préférence, autour de 15-30 degrés.

18. Réseau d'antennes à double polarisation (111, 200a, 200b, 200c, 200d) selon la revendication 16 ou 17, dans lequel le motif de puissance d'antenne est configuré en fonction d'une zone de couverture souhaitée du réseau d'antennes (111, 200a, 200b, 200c, 200d).

19. Réseau d'antennes à double polarisation (111, 200a, 200b, 200c, 200d) selon l'une quelconque des revendications 16-18, dans lequel le premier port d'antenne de réception (RX1) et le second port d'antenne de réception (RX2) sont agencés pour présenter des polarisations mutuellement orthogonales.

20. Réseau d'antennes à double polarisation (111, 200a, 200b, 200c, 200d) selon l'une quelconque des revendications 16-19, dans lequel le réseau d'alimentation (230) du réseau d'antennes (111, 200a, 200b, 200c, 200d) est configuré pour une réception en changeant des associations entre des ports d'antenne du réseau d'antennes et des éléments d'antenne à la fois de la première et de la seconde polarisation, comparée à la configuration du réseau d'alimentation pour le réseau d'antennes lorsqu'il est configuré pour une transmission.

21. Réseau d'antennes à double polarisation (111, 200a, 200b, 200c, 200d) selon l'une quelconque des revendications 16-20, dans lequel le réseau d'antennes (111, 200a, 200b, 200c, 200d) comprend N/2 éléments d'antenne de la première polarisation (pol A) et N/2 éléments d'antenne de la seconde polarisation (pol B), dans lequel le port d'antenne de transmission (TX) est raccordé à tous les N éléments d'antenne, le premier port d'antenne de réception (RX1) est raccordé aux N/2 éléments d'antenne parmi les N éléments d'antenne et le second port d'antenne de réception (RX2) est raccordé aux N/2 éléments d'antenne restants.

22. Réseau d'antennes à double polarisation (111, 200a, 200b, 200c, 200d) selon l'une quelconque des revendications 16-21, dans lequel le réseau d'antennes (111, 200a, 200b, 200c, 200d) comprend N/2 éléments d'antenne de la première polarisation (pol A) et N/2 éléments d'antenne de la seconde polarisation (pol B), dans lequel le port d'antenne de transmission (TX) est raccordé à tous les N éléments d'antenne, et dans lequel les premier et second ports d'antenne de réception (RX1, RX2) sont tous les deux raccordés à tous les N éléments d'antenne.

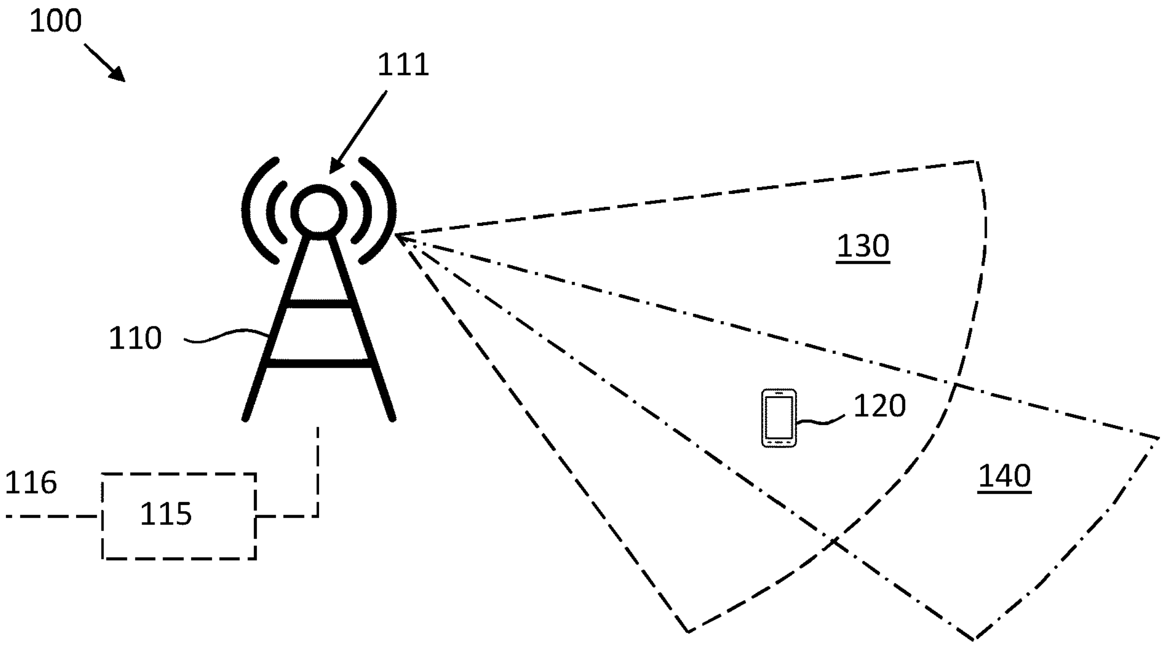

FIG. 1

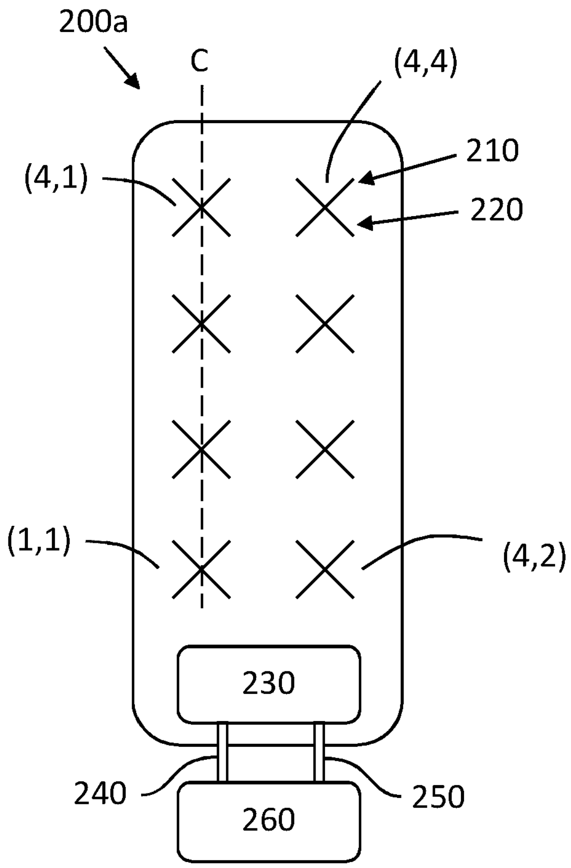

FIG. 2A

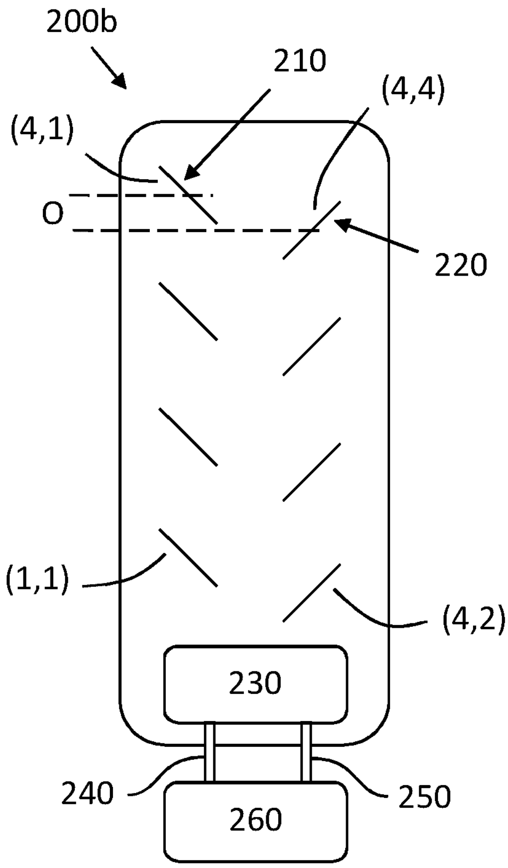

FIG. 2B

300

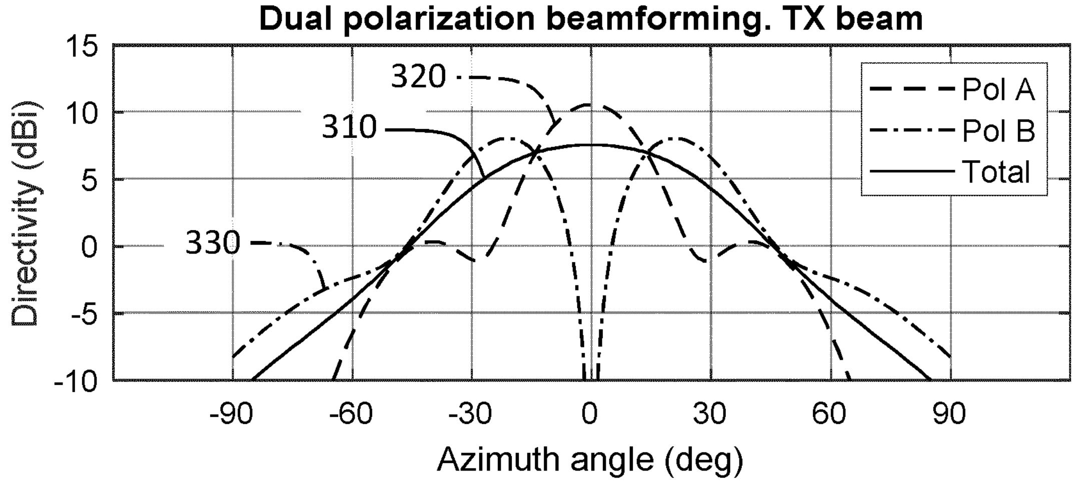

FIG. 3

400

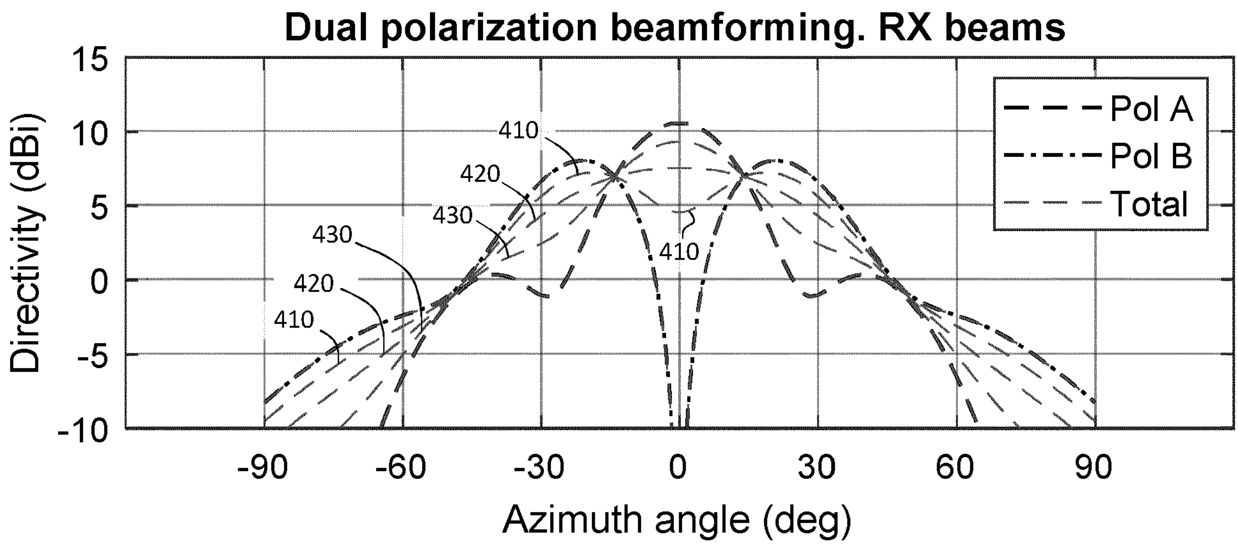

FIG. 4

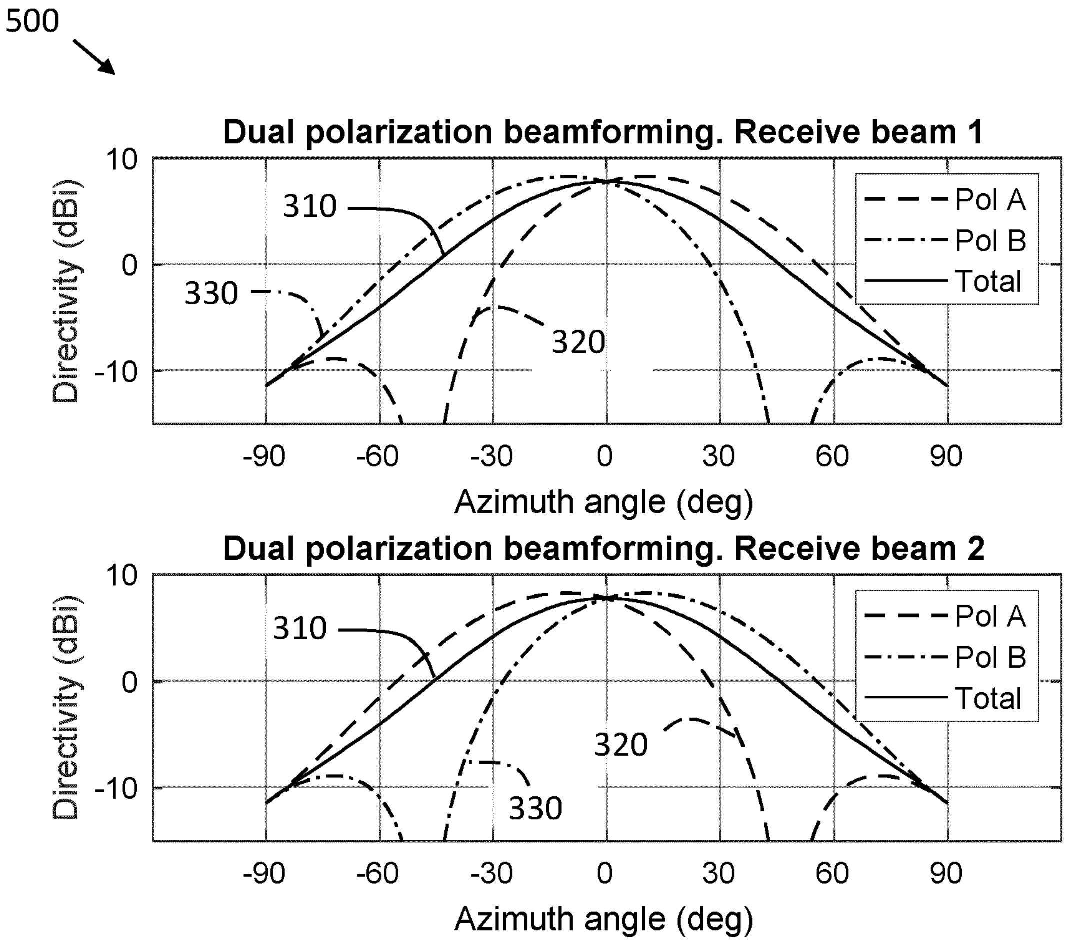

FIG. 5

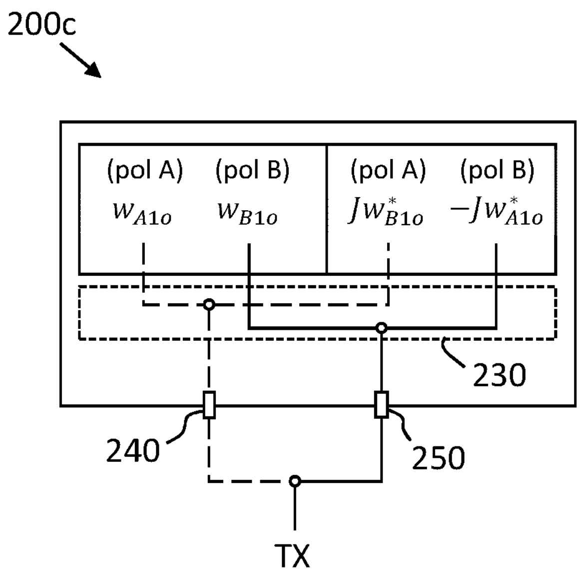

FIG. 6

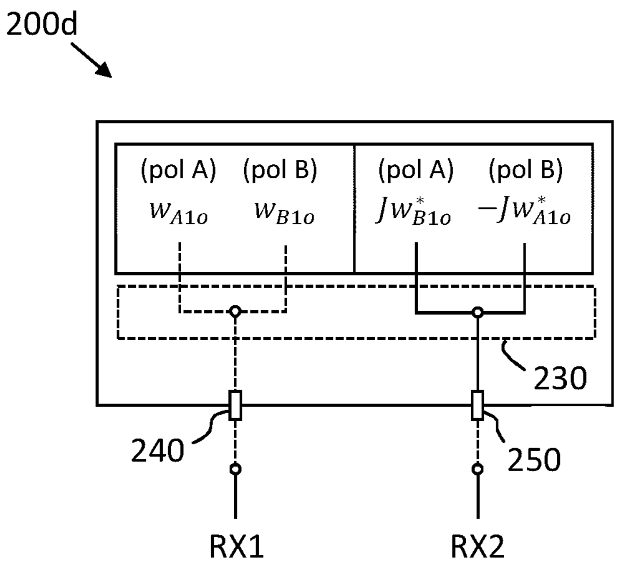

FIG. 7

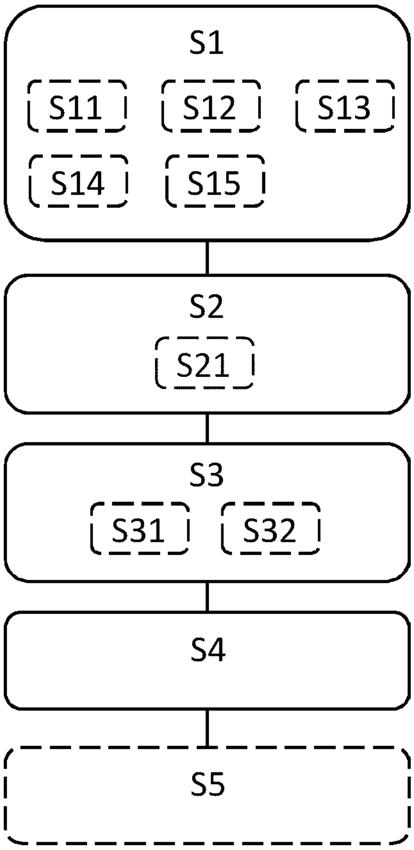

FIG. 8

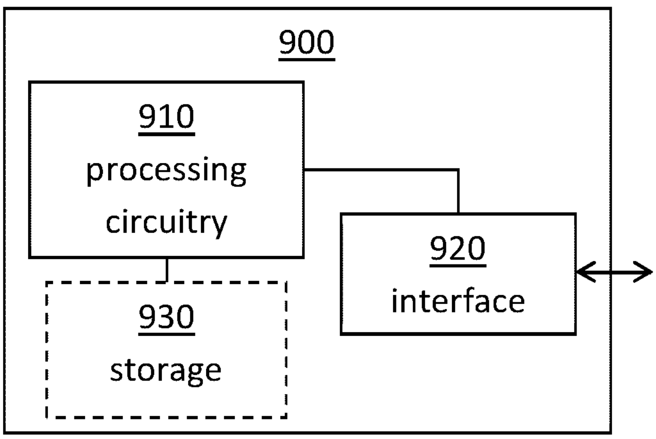

FIG. 9

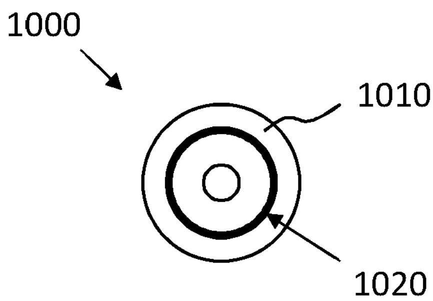

FIG. 10

REFERENCES CITED IN THE DESCRIPTION

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- US 20170352953 A1 **[0027]**